EXPLANATION

Source: Washoe County, 1:24,000, 1994, Provisional

Major ions, in proportion of total milliequivalents per liter, and other

water-quality characteristics—Number at top indicates site listed in

Irrigated area (park,

Lake, open water

Undesignated

golf course, agriculture)

A Primary Maximum Contaminant Level

3 Nitrite plus nitrate (see table 4)

7 Tetrachloroethylene (see table 6)

B Synthetic organic compound detected

1 Volatile organic compound (see table 6)

exceeded (see table 1)

1 Fluoride (see table 3)

2 Uranium (see table 3)

4 Arsenic (see table 5)

5 Cadmium (see table 5)

6 Benzene (see table 6)

2 Pesticide (see table 7)

Land use

B2 Magnesium

Vacant, rural

Residential

Industrial, utilities

Concentration of dissolved solids.

Shallow monitoring well

Water-supply well

in milligrams per liter

INTRODUCTION

In 1991, the U.S. Geological Survey (USGS) began a full-scale National Water-Quality Assessment (NAWQA) program to describe the status of and trends in the quality of the Nation's water resources, and to provide a scientific understanding of the primary natural and human factors that affect water quality. The NAWQA program consists of 60 of the Nation's most important river basins and aquifer systems, referred to as study units. These study units represent a large part of the national water use and population served by publicwater supplies. In 1991, the Nevada Basin and Range (NVBR) was among the first 20 NAWQA study units selected for investigation under the full-scale implementation plan. The NVBR study unit consists of three drainage basins, the Las Vegas Valley area in southeast Nevada, and the Carson and Truckee River Basins in northwest Nevada and northeast California (see index map, fig. 1). NAWQA studies will provide nationally consistent information that can be used to describe the quality of the Nation's water resources, to define the conditions and trends in water quality, and to identify, describe, and explain the major factors that affect water-

As part of the NVBR NAWQA program, networks of monitoring wells were established in the Reno-Sparks area (fig. 1) to evaluate the effects of urban land use on shallow (less than 80 ft below land surface) ground-water quality and to assess principal ground-water resources. Water sampled from the shallow monitoring wells is the ground water most likely to indicate contamination from sources at the land surface. Water sampled from the water-supply wells should be representative of the area's principal ground-water resources.

Purpose and Scope

quality conditions and trends.

The purpose of this report is to present the water-quality and ancillary data collected from 28 shallow monitoring wells during May to August 1994 and from 18 water-supply wells during June to September 1995 in the Reno-Sparks area. These ground-water-quality and ancillary data were collected as part of the NVBR NAWQA program. Available information and data also are used to describe climate, hydrogeology, population, land use, and water use in the Reno-Sparks area. This information is useful for understanding the hydrologic setting of the area and factors that affect water quality.

Acknowledgments

The USGS expresses appreciation to the following entities and individuals who gave permission for installing monitoring wells or for sampling existing wells in the Reno-Sparks area: Washoe County Parks and Recreation; Washoe County Public Works, Utility Division; Washoe County Buildings and Grounds; Mike Hirose, Washoe County School District; Kevin Weatherford, City of Reno Parks and Recreation: City of Sparks Parks and Recreation; Robert Squires, Sierra Pacific Power Company; and Jerry Conners, Nevada Division of Environmental Protection. The following USGS Nevada District personnel assisted in the installation and sampling of ground-water-monitoring wells: Kip K. Allander, Ronald P. Collins, Kathryn C. Kilroy, Michael S.

Physiographic Setting

Lico, Robert N. Pennington, and Armando R. Robledo.

The Reno-Sparks area lies within the north-central part of the Truckee Meadows Hydrographic Area¹ (see index map on fig. 1). Altitudes range from about 10,800 ft above sea level at Mt. Rose, southwest of the Reno-Sparks area, to about 4,400 ft where the Truckee River flows out of the Truckee Meadows east of the Reno-Sparks area. The principal stream traversing the area is the Truckee River, which originates from Lake Tahoe in the Sierra Nevada southwest of the Truckee Meadows.

The general climate of the Truckee Meadows is classified as a mid-latitude steppe, which is characterized by warm to hot summers and winters at or below freezing (Houghton and others, 1975, p. 4). In Reno during 1981-91, the average maximum summer temperature was 86°F and the minimum was 47°F; the average maximum winter temperature was 47°F and the minimum was 21°F (Covay and others, 1996, p. 19).

Precipitation in the Truckee Meadows is attenuated by the rainshadow of the Sierra Nevada. Annual precipitation decreases with decreasing altitude, but the relation varies seasonally. The average annual precipitation in Reno for 1981-91 was 7.33 in. (Covay and others, 1996, p. 21).

Hydrogeologic Setting

The hydrogeologic setting of the Truckee Meadows has been described by Cohen and Loeltz (1964). Valleyfill deposits have been categorized into three units. These units are the Truckee Formation, the older alluvium, and the younger alluvium. The Truckee Formation consists of fine-grained, unconsolidated and partly consolidated lacustrine sediments intermixed with stream-channel and alluvial sediments. The older alluvium primarily consists of erosional debris mixed with poorly sorted stream-channel and lacustrine deposits and angular colluvium. The younger alluvium consists of lacustrine sediments and coarse-grained fluvial deposits. Unconsolidated deposits in the Truckee Meadows can exceed 4,000 ft in thickness. These unconsolidated deposits contain large amounts of ground water. Water yields vary among wells in the unconsolidated deposits because of local differences in porosity and permeability. Moderately to highly porous and permeable sands and gravels are present beneath lowland areas of Truckee Meadows north of the Huffaker Hills (fig. 1). These deposits should allow development of moderate- to high-capacity wells (Cohen and Loeltz, 1964, p. 13-14). According to Cohen and Loeltz (1964, p. 9), the consolidated rocks of the mountains to the east and west of Truckee Meadows have low permeability and do not store or yield large amounts of water.

The general direction of ground-water flow in the Truckee Meadows south of the Huffaker Hills is from southwest to northeast (Cohen and Loeltz, 1964, p. 12). North of the Huffaker Hills, the general direction of ground-water flow is from west to east and from northwest to southeast. The effect of Huffaker Hills on groundwater flow is not completely understood; however, these hills are not a complete barrier to ground-water flow (Cohen and Loeltz, 1964, p. 19).

Aquifers in the Truckee Meadows are recharged by infiltration of irrigation water, streamflow, and precipitation, and by underflow from tributary valleys. Most of the recharge is from infiltration of irrigation water and Truckee River water. Discharge of ground water primarily is by evapotranspiration and seepage to streams and ditches. When recharge is greater than discharge, water levels rise, and when recharge is less than discharge, water levels decline (Cohen and Loeltz, 1964, p. 27).

A study by Van Denburgh and others (1973) indicated that ground water suitable for most uses was available in the Truckee Meadows, but that problem areas existed. Excessive concentrations of arsenic and manganese were present at depths exceeding about 250 ft, arsenic and fluoride concentrations were excessive on the western side of the valley, and generally poor-quality water was present in and downgradient from areas of bleached bedrock north of Reno and at other locations at valley margins (Van Denburgh and others, 1973, p. 80). Bleached rocks are formed near the land surface when pyrite, precipitated in the rocks by hydrothermal alteration, is oxidized and the resulting sulfuric acid "bleaches" the rocks (Cohen and Loeltz, 1964, p. 10). This process can introduce large amounts of sulfate into adjacent water (Cohen and Loeltz, 1964, p. 44-45).

Population and Urbanization

The Reno-Sparks area is the most urbanized part of the Truckee River Basin. In 1990, the population of the Truckee River Basin was about 290,000 people (Wayne Solley, U.S. Geological Survey, written commun., 1991); more than 65 percent of the population resided in the Reno-Sparks area (Nevada State Demographer, Bureau of Business and Economic Research, written commun., 1991). From 1984 to 1994, the population of the Reno-Sparks area increased by about 30 percent.

Water and Land Use

Approximately 262,000 acre-ft of water were used in the Truckee River Basin during 1990 (about 76 percent surface water and 24 percent ground water; E. James Crompton, U.S. Geological Survey, written commun., 1992). The largest uses of water in 1990 were for irrigation (about 59 percent) and public-water supply (about 36 percent). Nearly half of the public supplies in the basin are provided by ground-water withdrawals in the Reno-

Historically, land use in the Truckee Meadows was primarily agricultural. Currently, the acreage of agricultural land is declining because of accelerated urbanization in the Reno-Sparks area. Land use in the Truckee River Basin is 53 percent range, 27 percent forest, 12 percent open water and wetlands, 3 percent urban, 3 percent barren, and 2 percent irrigated agriculture (Kilroy and others, in press). Figure 1 shows the Reno-Sparks area further divided into vacant and rural, residential, commercial, industrial and utility, irrigated (park, golf course, agriculture), and undesignated land uses. Urban activities can affect the quality of water resources by introducing chemical constituents associated with sewage, industrial discharges or spills, landscape fertilization and pest control, automobiles, and other sources.

METHODS OF INVESTIGATION

Site Selection and Well-Installation Procedures

The 28 shallow monitoring wells and the 18 water-supply wells sampled for the NAWQA ground-water monitoring networks in the Reno-Sparks area are shown in figure 1. The shallow wells at sites 1-6, 10, 12-25, and 28 were installed by NVBR project personnel in April-July 1994, according to NAWQA protocols (Hardy and others, 1989; Lapham and others, 1995). The wells were drilled using continuous-flight augering techniques without the use of drilling fluids. Casing and screen material consisted of 2-in.-inside-diameter, threaded, schedule-40 polyvinyl chloride (PVC). The casing and well screens were precleaned and sealed in plastic until installation. Shallow monitoring wells were screened within 50 ft of the land surface, except sites 21 and 28, which were screened from 47-57 ft and 63-78 ft, respectively. All newly installed wells were developed using bailing or pumping techniques and at least 25 well-bore volumes of water were removed prior to sampling.

The other six shallow monitoring wells (sites 7-9, 11, 26, and 27) were selected from monitoring wells maintained by the Nevada Division of Environmental Protection, Washoe County, and the City of Reno. These six wells were selected to comply with NAWQA well-installation protocols to the fullest possible extent and, in conjunction with the NVBR installed wells, to provide good coverage of the Reno-Sparks area.

The 18 water-supply wells were selected from wells installed by water purveyors or individuals. These wells were used for public or domestic supplies. Water-supply wells generally were screened or perforated within the interval of 105 ft to 750 ft below land surface. Water-supply wells were selected from available wells to comply with NAWQA protocols as much as possible and to provide good areal coverage.

Sample Collection and Analysis

Water level: Measured on sampling date, before pumping or bailing.

microsiemens per centimeter at 25 degrees Ceisius; --, not determined]

Sampling methods used for the ground-water-monitoring networks followed protocols developed for the NAWQA program, as described by Hardy and others (1989), Koterba and others (1995), and Lapham and others (1995). Prior to sampling the shallow monitoring wells, standing water in the casing was removed by purging at least three well-bore volumes of water. Water samples from most of the shallow monitoring wells were pumped to the surface by a bladder pump with Teflon² and Teflon-coated delivery materials. A few low-yielding shallow monitoring wells were sampled with disposable Teflon bailers. All water samples from water-supply wells were taken from a spigot as close to the well head as possible and before any water-treatment process. Water temperature, pH, dissolved oxygen, and specific conductance were monitored during purging of all monitoring wells using a flow-through chamber to reduce contact of the sample with the atmosphere. Samples were collected after these measurements stabilized.

Quality-assurance samples including replicates, field blanks, trip blanks, and field spikes were collected and analyzed. These types of quality-assurance samples are described by Koterba and others (1995). Such samples allow evaluation of variability introduced by sampling equipment and field, laboratory, and recovery procedures. Data for the quality-assurance and ground-water samples collected from all monitoring wells were published in the 1994 and 1995 data reports for Nevada (Clary and others, 1995, p. 710-717; Bauer and others, 1996, p. 666-

Table 2. Selected well-completion information, water levels, and on-site measurements of physical and chemical properties of water for monitoring wells in Reno-Sparks area, 1994-95 USGS Site identification number: Standard site identification is based on grid system of latitude and longitude. Number consists of 15 digits. First six digits denote degrees, minutes, and seconds of latitude; next seven digits denote degrees, minutes, and seconds of longitude; and last two digits (assigned sequentially) identify sites within a 1-second grid. For example, site 393328119432001 is at 39°33′28" latitude and 119°43′20" longitude, and is first site recorded in that 1-second grid. Assigned number is retained as permanant identifier even if more precise latitude and longitude are later determine Total depth of well: Sources of information are drillers' logs (on file at Nevada Division of Water Resources or U.S. Geological Survey, Carson City, Nev.).

[Specific conductance, pH, water temperature, and dissolved oxygen were measured in the field. Abbreviations and symbol: °C, degrees Celsius; mg/L, milligrams per liter, µS/cm.

Site no. (flg. 1)	USGS site identification number	Date sampled	Land- surface altitude (feet)	Total well depth (feet below land surface)	Screened or perforated interval (feet below land surface)	Water level (feet below land surface)	Specific conductence (µS/cm)	pH (stendard units)	Water temperature (°C)	Oxygen, dissolved (mg/L)
				Sh	allow Monitorin	g Wells			-	
1	393328119432001	06-08-94	4,405	22	18-22	4.94	588	7.8	12.0	0.2
2	393257119441401	07-21-94	4,408	24	14-24	11.20	878	7.5	16.0	0.3
3	393249119422901	07-20-94	4,400	20	10-20	7.50	1,660	7.6	15.0	.3
4	393022119444301	08-03-94	4,405	32	22-32	9.70	688	6.7		.1
5	393211119472901	08-01-94	4,450	34	24-34	23.61	897	7.2	14.0	.2
6									13.5	
7	393206119425301	07-18-94	4,390	36	26-36	25.72	1,120	7.4	14.0	1.0
8	393139119493401	06-21-94	4,530	33	13-33	28.99	1,060	6.7	17.0	**
	393132119485801	08-15-94	4,500	40	10-40	23.00	440	6.7	23.5	.3
9	393132119482201	06-22-94	4,490	49	36-46	21.40	321	6.6	15.0	3.6
10	393132119422801	06-01-94	4,386	25	18-25	13.26	2,160	7.4	17.0	.3
11	393131119490001	07-27-94	4,500	30	17-27	14.66	217	7.0	18.5	.2
12	393123119452301	05-26-94	4,409	15	10-15	8.10	372	7.7		
13	393055119482001	08-02-94	4,470	29	19-29	6.33	518		14.0	
14	393054119445501	05-24-94	4,400	15	10-15	10.50		7.5	17.0	.8
15	393045119500701	06-20-94	4,550	29	22-29		700	6.6	16.0	.4
						18.60	505	6.5	14.0	
16	393033119465401	06-02-94	4,422	38	33-38	20.63	1,010	7.1	15.5	1.9
17	393032119473501	07-26-94	4,435	39	29-39	19.80	815	7.0	16.5	1.9
18	393017119533101	06-07-94	4,625	15	10-15	7.37	521	7.1	12.0	
19	392944119440301	06-23-94	4,390	20	15-20	6.66	475	7.7	13.5	.2
20	392937119452601	05-19-94	4,395	15	10-15	5.12	737	7.4	13.0	.3
21	392927119475201	07-19-94								
22	392917119464901		4,460	57	47-57	33.55	569	7.9	29.0	1.5
		05-18-94	4,410	15	10-15	8.42	1,190	8.1	11.0	
23	392855119462301	05-23-94	4,417	25	20-25	5.20	791	7.1	16.0	.2
24	392744119464601	06-30-94	4,460	28	23-28	22.11	492	6.8	14.5	
25	392726119460101	05-17-94	4,460	35	25-35	10.20	521	6.9	15.0	.4
26	392554119455801	05-31-94	4,540	35	22-32	33.63	466	6.8	15.0	
27	392459119433701	08-04-94	4,501	23	9-23	12.79	970			
28	392403119434301	07-28-94	4,580	78	63-78	62,48		7.1	14.0	1.7
		0, 20) .	4,500				521	7.0	14.0	6.6
20	20222211212222				Water-Supply W	ells				
29	393203119472801	06-22-95	4,475	583	203-441		501	7.8	15.5	3.8
30	393158119454301	06-02-95	4,420	665	453-645	99.22	290	7.8	17.5	2.2
31	393145119452401	06-26-95	4,410	274	110-126		302	7.9	17.0	
			1,1.10	2.7	130-170		302	1.9	17.0	1.0
					176-260					
32	393127119471101	07-31-95	4,410	685			404			
33	393105119494001	08-01-95	4,510		100 220		404	8.1	20.0	.4
34	393053119445601			456	180-230		457	7.6	18.0	3.6
54	393033119443001	06-28-95	4,400	191	105-125		304	7.4	18.0	1.4
35	202045110500501	07.31.05	4.550	40.0	151-191					
33	393045119500501	06-21-95	4,550	485	215-300	74.5	466	7.6	18.0	4.7
5.5					310-475					
36	393043119504901	09-20-95	4,563	360	170-224		407	7.8	14.5	3.8
					233-259					
					262-350					
37	392927119475601	06-29-95	4,470	470	360-460		814	7.9	40.0	1.2
	392742119484501	08-02-95	4,715	185			272	7.1	18.0	1.3
	392718119463401	06-27-95	4,480	286	110-272		290	7.4		4.5
	392636119464401	08-01-95	4.530	336	177-321		228		18.5	2.5
								7.0	16.0	3.0
	392627119481901	08-02-95	4,700	242			423	7.2	18.0	. 5.2
	392614119454501	06-28-95	4,490	429	130-408		159	7.7	18.5	4.8
	392506119462201	06-19-25	4,690	530	260-520	311	212	7.6	19.0	5.4
	392414119474701	06-21-95	5,193	760	400-750		227	7.2	18.0	5.4
45	392404119434501	07-18-95	4,580	204	176-200		440	7.2	15.0	5.5
43										

Analyses for major dissolved ions and trace elements were made by the USGS National Water Quality Laboratory in Arvada, Colo., according to USGS protocols (Fishman and Friedman, 1989; Welsch and others, 1990). Analytical results reported as "dissolved" were determined from samples filtered through a 0.45-micrometer-poresize, capsule filter. Analyses of nutrients, radionuclides, pesticides, and volatile organic compounds were made by the USGS National Water Quality Laboratory using USGS approved methods (Thatcher and others, 1977; Wershaw and others, 1987; Fishman and Friedman, 1989; Rose and Schroeder, 1995). Field analyses of alkalinity and bicarbonate were made on-site using the protocol described by Shelton (1994).

DISCUSSION OF DATA ON GROUND-WATER QUALITY

Drinking-water regulations for chemical constituents are used in the following discussions to allow comparisons with analyses of ground-water samples. Comparisons of ground-water quality with these regulations serve primarily to provide an indication of the general quality of ground water in the Reno-Sparks area. Even though only the watersupply wells are used as sources of drinking water, water samples from shallow monitoring wells also are compared with regulations. Water that meets these drinking-water regulations is considered to be of good chemical quality and suitable for most uses. Microbiological parameters (including Giardia lamblia and total coliform bacteria) were not determined by this study, but are subject to drinking-water regulations.

Drinking-water regulations (table 1) are defined by the U.S. Environmental Protection Agency (USEPA) to ensure that safe drinking water is supplied to the public (U.S. Environmental Protection Agency, 1996). Waterquality regulations include primary maximum contaminant levels (MCL's), secondary maximum contaminant levels (SMCL's), and adult lifetime health advisories (HA's). Both MCL's and SMCL's are enforceable for public water supplies in Nevada. SCML's are based on aesthetics. If exceeded, SMCL's may not cause health problems but may result in water that is unpleasant to drink, primarily due to undesirable odor, taste, or appearance. The HA is the maximum concentration in drinking water that is not expected to cause any adverse effects over a lifetime of exposure, with a margin of safety.

Information on well completion and on-site measurements of water levels and physical and chemical properties of the ground water sampled are presented in table 2. These measurements were made just prior to the collection of ground-water samples for chemical analyses.

Measurements of pH in water from the shallow monitoring wells ranged from 6.5 to 8.1 and in water from the supply wells ranged from 7.0 to 8.1. All pH measurements were within the SMCL range of 6.5 to 8.5 (table 2). Temperatures in water from the shallow monitoring wells ranged from 12.0°C at well 1 to 29.0°C at well 21 and in water from the supply wells ranged from 14.5°C at well 36 to 40.0°C at well 37 (table 2). The water temperature at well 37 probably is the result of geothermal activity. Aquifers containing ground water with temperatures greater than 30°C are "thermal aquifers" (Thomas and Lawrence, 1994, p. 11).

Chemical compositions of water in the shallow monitoring and water-supply wells in the Reno-Sparks area are illustrated in figure 1 by proportional area diagrams. On the diagram, the area of the circle represents the total concentration of ions in the sample, in milliequivalents per liter, and the area of each wedge-shaped slice represents the percentage of a particular ionic constituent (Briel, 1993). The cations are the left half of the circle and the anions are the right half of the circle. If the concentrations of the cations and the anions are equal, the circle will be divided into equal halves. A single cation is used to describe the chemical type of the water if it amounts to 50 percent or more of the total cations and a single anion is used if it amounts to 50 percent or more of the total anions. If no cation or anion is dominant, the two cations and two anions with the highest percentages are used to describe the water type. Data on major ions used to develop the proportional area diagrams are presented in table 3.

The most common chemical types of water in the shallow monitoring wells (1-28) were calcium bicarbonate and sodium bicarbonate. Calcium was the dominant cation in water from most shallow monitoring wells; however, exceptions such as wells 3, 6, 16, 17, 21, and 22, had sodium as the dominant cation. In water from several wells, such as wells 24 and 26, magnesium was the codominant cation. Bicarbonate was the most common dominant anion. Sulfate was the dominant anion in water from well 15 and was the codominant anion in water from well 10.

Proportional-area diagrams of water from the water-supply wells (29-46) indicate chemical types similar to water from the shallow monitoring wells. The most common chemical types of water in the water-supply wells (29-46) were calcium bicarbonate or calcium magnesium bicarbonate. Calcium was the dominant cation in water from most water-supply wells; however, in wells 32 and 37 sodium was dominant. Calcium and magnesium were the codominant cations in water from some water-supply wells, such as 40 and 42. Bicarbonate was the dominant anion in water from all water-supply wells except where sulfate was codominant (well 32) or dominant (well 37).

In the northeastern part of the Reno-Sparks area, sodium was the dominant cation in water from shallow monitoring wells 3 and 6. Water from wells 16, 17, 21, 22, 32, and 37, in the central part of the area, had sodium as the dominant cation. Calcium was the dominant cation in water from nearly 60 percent of the sampled wells, and sodium was dominant in nearly 24 percent. Magnesium commonly was a codominant cation. Bicarbonate was the most common anion and was dominant in water from nearly 94 percent of the sampled wells. In the west-central part of the area, sulfate was the dominant anion in water from wells 15 and 37.

Dissolved-solids concentrations (calculated as the sum of dissolved constituents) ranged from 137 to 1,460 mg/L in water from the shallow monitoring wells and from 149 to 548 mg/L in water from the water-supply wells (table 3). The final SMCL for dissolved solids (500 mg/L, table 1) was exceeded in 10 of 28 water samples from shallow monitoring wells (wells 2, 3, 5-7, 10, 16, 17, 22, and 27), but in only 1 of 18 samples from water-supply wells (well 37). Sulfate exceeded the final SMCL of 250 mg/L (table 1) only in the sample from shallow monitoring well 10 with a concentration of 490 mg/L (table 3). Dissolution of minerals in most rocks and soils can increase concentrations of dissolved solids in ground water, and the presence of industrial or agricultural wastewater can increase the dissolved-solids concentration in water. Evapotranspiration also can concentrate dissolved solids in shallow ground water in arid climates.

The MCL for fluoride (4 mg/L, table 1), which is under review, was exceeded in the water sample from shallow monitoring well 22 (table 3). Fluoride minerals are present in both igneous and sedimentary rocks. Fluoride is commonly associated with volcanic or fumarolic gases, which may be important sources of fluoride for natural water in some areas (Hem, 1985, p. 121).

Radon activities equaled or exceeded the formerly proposed MCL of 300 picocuries per liter (table 1) in water samples from all wells except well 12, which had an activity level of 250 picocuries per liter (table 3). The proposed radon MCL has been cancelled by the USEPA. Hem (1985, p. 149) indicates that radon-222 is a soluble, naturally occurring radioisotope derived from radium (in a radioactive-decay series beginning with uranium-238). Uranium concentrations (table 3) exceeded the proposed MCL of 20 micrograms per liter (µg/L) in 7 of 28 water samples from shallow monitoring wells (wells 3, 5, 7, 10, 13, 20, and 25), but did not equal or exceed the proposed MCL in water from any supply wells. Concentrations of uranium in ground water are controlled largely by the occurrence of uranium in rocks and soils, and by redox conditions in the water (Hem, 1985, p. 1482).

Concentrations of nitrite plus nitrate equaled the final MCL (10 mg/L as N, table 1) in the water sample from shallow monitoring well 7 (table 4). All other nitrite plus nitrate concentrations in the wells were below the final MCL. Concentrations exceeding the final MCL may cause methemoglobinemia or "blue baby syndrome" in small children (Hem, 1985, p. 125). Potential sources of nitrate in ground water include domestic sewage, animal wastes, fertilizers, leguminous plants, and spring deposits (Hem, 1985, p. 125-126). Nitrate is highly soluble in water, stable over a wide range of environmental conditions, and readily transported in ground and surface waters (Mueller and

Dissolved trace-element concentrations in water samples from the shallow monitoring and water-supply wells are listed in table 5. Arsenic exceeded the MCL of 50 µg/L (table 1), which is under review, in water samples from 4 of the 28 shallow monitoring wells (17, 21, 22, and 27) and 2 of the 18 water-supply wells (32 and 37). Arsenic is a common constituent of geothermal water (Hem, 1985, p. 144-145). The two wells that had the highest water temperatures, shallow monitoring well 21 (29.0°C) and water-supply well 37 (40.0°C), are adjacent to each other (fig. 1) and had water with 130 and 92 μg/L of arsenic, respectively. Cadmium exceeded the final MCL (5 μg/L, table 1) in the water sample from water-supply well 39 with a concentration of 16 µg/L. Cadmium is present in zinc minerals such as sphalerite and is sometimes recovered from copper ores during smelting and refining (Hem, 1985, p. 142). Cadmium is used for electroplating and for pigments used in paint, printing ink, and plastics; it also is used extensively as a stabilizer for PVC and in electrical batteries and fluorescent and video tubes (Hem, 1985, p. 142). Iron exceeded the final SMCL (300 µg/L, table 1) in the water sample from shallow monitoring well 11 with a concentration of 2,300 µg/L. Iron is an essential trace element for plants and animals; however, in high concentrations, iron in water supplies can be objectionable for domestic and industrial purposes. Manganese exceeded the final SMCL (50 µg/L, table 1) in water samples from 17 of 28 shallow monitoring wells (wells 2, 4, 6-8, 10-12, 14-20, 23, and 24), but only the sample from water-supply well 32 exceeded the final SMCL. Although manganese is an essential element for plants and animals, it is undesirable in water supplies. Molybdenum exceeded the draft HA (40 μg/L, table 1) at shallow monitoring well 22 with a concentration of 500 μg/L. Molybdenum is a rare element; it is essential for animal and plant nutrition, especially legumes, and tends to accumulate in vegetation (Hem, 1985, p. 140). Molybdenum is used extensively as an alloy in steel and in welding rods; it is used also as a lubricant additive and in ceramics (Hem, 1985, p. 140). All other trace-element concentrations in water from the wells were within USEPA regulations.

Synthetic organic compounds classified as volatile organic compounds (VOC's) and pesticides are shown in tables 6 and 7, respectively. Only those organic compounds that were detected in at least one sample are included in the tables. Concentrations of VOC's were below MCL's and HA's in all but two water samples. Concentration of the VOC benzene equaled the final MCL of 5 µg/L (table 1) in the water sample from shallow monitoring well 7. Benzene is used as a constituent in motor fuels and in the manufacture of styrene, phenol, detergents, pesticides, paints, and plastics (Smith and others, 1988, p. 44). The VOC tetrachloroethylene exceeded the final MCL of 5 µg/L in water samples from shallow monitoring wells 7 and 17 with concentrations of 15 and 20 µg/L, respectively. Tetrachloroethylene is frequently used as a industrial solvent for dry cleaning and as a metal degreaser (Smith and

Phenols and chloroform were the most frequently detected VOC's in ground-water samples from the Reno-Sparks area. Phenols were detected in samples from 39 percent of the shallow monitoring wells and in samples from 33 percent of the water-supply wells at concentrations ranging from 1 to 4 µg/L (table 6). The draft HA for phenols is 4,000 µg/L (table 1). The analysis of phenols is a gross analysis of total phenol concentration. Phenols are used primarily as industrial chemicals for the production of phenolic resins, germicides, pharmaceuticals, fungicides, dyes, herbicides, plastics, explosives, and skin medications (Smith and others, 1988, p. 44).

Chloroform was detected in water samples from six of the shallow monitoring wells and from five of the watersupply wells. Concentrations ranged from 0.3 to 1.2 µg/L (table 6), which are below the final MCL of 100 µg/L (table 1). Chloroform is a trihalomethane and is used in the manufacture of fluorocarbon refrigerants, propellants, plastics, anesthetics, and pharmaceuticals (Smith and others, 1988, p. 44). Chloroform also can be produced during the chlorination of water supplies or when chlorine combines with dissolved organic carbon in water (Thodal, 1992,

Methyl tert-butyl ether (MTBE) was detected in water samples from six shallow monitoring wells ranging in concentration from 0.3 to 220 µg/L (table 6). In water samples from wells 4 and 7, the MTBE concentrations were 140 and 220 μg/L, respectively; the draft HA is 20-200 μg/L (table 1). MTBE is a gasoline additive (fuel oxygenate) that is used to increase the octane of gasoline and improve air quality in urban areas (Squillace and others, 1996, p. 1721). Sources of MTBE into the environment are not well quantified, but spills at the land surface and leaking underground storage tanks are known sources of contamination (Squillace and others, 1996, p. 1726-1727).

Pesticides detected in the Reno-Sparks area during the sampling period are listed in table 7. At least one pesticide was detected in 19 of the 28 water samples from shallow monitoring wells and in 8 of the 18 water samples from water-supply wells. More than one pesticide was detected in water samples from shallow monitoring wells 12 and 24 (5 pesticides each); 2 (4); 4 (3); 6, 7, 13, 15, 18, 23, and 26 (2 each); and from water-supply wells 34 (4) and 31, 37, and 39 (2 each).

Deethyl atrazine was detected in 11 shallow monitoring wells and 6 water-supply wells, and atrazine was detected in 10 shallow monitoring wells and 3 water-supply wells. None of the atrazine concentrations equaled or exceeded the final MCL of 3 µg/L. Currently, USEPA has no MCL or HA established for deethyl atrazine, which is a transformation product of atrazine (Barbash and Resek, 1996, p. 206-207). Prometon, detected at five shallow

Table 3. Major ions, dissolved solids, and radionuclides in water samples from monitoring wells in Reno-Sparks area, 1994-95

Site no. (fig. 1)	Calclum, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Potassium, dissolved (mg/L as K)	Alkalinity (mg/L as CaCO ₃)	Bicar- bonate (mg/L as HCO ₃)	Sulfate, dissolved (mg/L as SO ₄)	Chloride, diseolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Solids, dissolved, residue on evaporation (mg/L)	Solids, dissolved, sum of constituents (mg/L)	Radon- 222, tolal (pCi/L)	Uranium (natural), dissolved (μg/L as U)
		-				Shallow N	Ionitoring We	ells					
1 2 3 4 5	41 92 48 76 95	19 38 22 29 37	59 33 290 25 42	4.2 5.5 5.4 5.1 5.9	250 338 576 188 286	305 412 703 230 349	41 65 210 80 110	8.2 30 56 45 40	0.30 .20 .20 .10 .10	388 552 1,120 451 574	393 545 1,050 449 557	690 570 840 860 800	9.0 9.0 30 4.0 21
6 7 8 9	52 110 40 29 170	23 49 15 9.5 85	160 31 20 15 200	7.7 6.7 4.7 3.0 14	361 436 120 74 462	440 532 147 90 564	180 23 45 25 490	31 48 34 28 180	.10 <.10 .30 <.10 .20	748 608 284 185 1,540	719 611 269 192 1,460	560 1,200 1,500 1,300 600	17 27 1.0 <1.0 39
11 12 13 14 15	19 32 59 69 43	6.1 11 23 29 22	11 23 20 25 20	2.5 3.8 4.8 6.1 4.7	94 110 213 208 88	115 134 260 254 107	2.0 22 34 110 130	9.2 32 13 11 14	.10 .20 .20 .10	136 218 326 434 349	137 218 330 418 348	1,200 250 2,600 300 1,300	<1.0 2.0 21 3.0 <1.0
16 17 18 19 20	59 44 46 23 70	15 11 19 12 33	140 110 31 50 43	8.0 7.3 7.1 9.3 7.0	283 251 181 144 284	345 306 221 176 347	160 94 64 44 58	34 33 16 32 24	.50 1.4 .20 .30	652 563 343 308 476	675	710 1,100 650 360 670	13 8.0 3.0 <1.0
21 22 23 24 25	9.7 3.8 74 40 48	.98 2.2 31 26 22	110 280 48 20 22	5.5 5.7 6.5 7.6 8.3	154 385 286 226 219	188 470 349 276 267	94 190 75 22 23	12 28 15 12	3.3 5.0 .20 .10	434 804 521 320 359	423 813 490 330	460 640 720 700 1,300	1.0 4.0 7.0 4.0 23
26 27 28	36 96 55	24 26 14	17 70 33	8.5 9.6 2.4	164 408 238	200 498 290	30 22 11	16 54 16	.10 .30 .10	316 607 330	323 606 328	920 630 540	<1.0 11 <1.0
29	54	19	21	1.0			Supply Wells						
30	28	12	21 12	3.7 4.1	165 105	201 128	59 22	14 6.9	.10 <.10	340 201	334 201	470 690	7.0 3.0
31 32 33 34 35	23 4.2 49 26 46	10 1.7 16 10 16	21 76 21 17 22	4.5 6.6 3.9 3.7 3.8	106 88 142 106 151	129 107 173 129 184	28 86 67 20 52	7.1 6.7 8.3 8.4	.10 .40 <.10 .10 <.10	203 294 300 193 303	201 291 297 189 296	580 580 890 690 890	2.0 <1.0 3.0 2.0 4.0
36 37 38 39 40	40 15 22 23 18	.91 8.2 14	14 140 22 13 9.3	3.8 7.1 3.7 5.7 5.6	115 111 109 138 113	140 135 133 168 138	54 210 24 4.8 2.9	9.6 21 3.1 1.6 2.0	<.10 2.4 .20 <.10 <.10	263 572 221 209 186	250 548 225 215 198	820 360 950 760	2.0 <1.0 <1.0 3.0 2.0
41 42 43 44 45 46	45 11 17 17 40 28	16 7.8 9.7 11 9.7	22 8.2 9.8 9.8 34	4.7 5.0 5.6 4.9 7.6 4.6	198 79 87 92 194 163	242 96 106 112 237 199	13 3.1 2.8 2.9 7.6 4.6	6.6 .60 .80 1.8 12 6.1	.20 <.10 <.10 <.10 .20 <.10	275 147 164 166 287 226	281 149	760 960 960 1,100 930 300 530	3.0 2.0 3.0 3.0 <1.0 4.0

monitoring wells and three water-supply wells, and simazine, detected at seven shallow monitoring wells, were the third and fourth most frequently detected pesticides. All detections were well below the draft HA for prometon and final MCL for simazine (100 and 4 µg/L, respectively).

Atrazine, prometon, and simazine are water-soluble triazine herbicides used for crop and noncrop applications. The primary use of these herbicides is control of grass and broadleaf weeds (Meister Publishing Company, 1996, p. C34, C311, and C349). The use of triazine herbicides in the United States increased from 24 million pounds in 1966 to 104 million pounds in 1988, or 23 percent of the national herbicide use (U.S. Geological Survey, 1995).

¹ Formal hydrographic areas in Nevada were delineated systematically by the U.S. Geological Survey and the Nevada Division of Water resources in the late 1960's for scientific and administrative purposes (Rush, 1968; Cardinalli and others, 1968). The official hydrographic area names, numbers, and geographic boundaries continue to be used in U.S. Geological Survey reports and Nevada Division of Water Resources administrative activities.

² Any use of trade names in this publication is for descriptive purposes only and does not constitute

REFERENCES CITED Barbash, J.E., and Resek, E.A., 1996, Pesticides in ground water—Distribution, trends, and governing factors: Chelsea,

endorsement by the U.S. Government.

Mich., Ann Arbor Press, 588 p. Bauer, D.J., Foster, B.J., Joyner, J.D., and Swanson, R.A., 1996, Water resources data for Nevada, water year 1995: U.S. Geological Survey Water-Data Report NV-95-1, 734 p.

Briel, L.I., 1993, Documentation of a multiple-technique computer program for plotting major-ion composition of natural waters: U.S. Geological Survey Open-File Report 93-74, 88 p. Cardinalli, J.L., Rouch, L.M., Rush, F.E., and Vasey, B.J., comps., 1968, State of Nevada hydrographic areas: Nevada

Division of Water Resources map, scale 1:500.000. Clary, S.L., McClary, D.R., Whitney, Rita, and Reeves, D.D., 1995, Water resources data for Nevada, water year 1994: U.S. Geological Survey Water-Data Report NV-94-1, 768 p.

Cohen, Phillip, and Loeltz, O.J., 1964. Evaluation of hydrogeochemistry of Truckee Meadows Area, Washoe County, Nevada: U.S. Geological Survey Water-Supply Paper 1779-S. 59 p. Covay, K.J., Banks, J.M., Bevans, H.E., and Watkins, S.A., 1996, Environmental and hydrologic setting of the Las Vegas Valley area and the Carson and Truckee River basins, Nevada and California: U.S. Geological Survey Water-Resources Investigations Report 96-4086, 72 p.

Fishman, M.J., and Friedman, L.C., eds., 1989, Methods for determination of inorganic substances in water and fluvial sediments (3d ed.): U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A1, 709 p. Hardy, M.A., Leahy, P.P., and Alley, W.M., 1989, Well installation and documentation, and ground-water sampling protocols for the pilot National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 89-396, 36 p.

Hem, J.D., 1985, Study and interpretation of the chemical characteristics of natural water (3d ed.): U.S. Geological Survey Water-Houghton, J.G., Sakamoto, C.M., and Gifford. R.O., 1975, Nevada's weather and climate: Nevada Bureau of Mines and Geology Special Publication 2, 78 p.

Kilroy, K.C., Lawrence, S.J., Lico, M.S., Bevans, H.E., and Watkins, S.A., (in press), Water-quality assessment of the Las Vegas Valley area and the Carson and Truckee River Basins, Nevada and California—Nutrients, pesticides, and suspended sediment, October 1969-April 1990: U.S. Geological Survey Water-Resources Investigations Report 97-4106. Koterba, M.T., Wilde, F.D., and Lapham, W.W., 1995, Ground-water data-collection protocols and procedures for the National Water-Quality Assessment Program—Collection and documentation of water-quality samples and related data: U.S. Geological Survey Open-File Report 95-399, 113 p.

Lapham, W.W., Wilde, F.D., and Koterba, M.T., 1995, Ground-water data-collection protocols and procedures for the National Water-Quality Assessment Program— Selection, installation, and documentation of wells, and collection of related data: U.S. Geological Survey Open-File Report 95-398, 69 p. Meister Publishing Company, 1996, Farm chemicals handbook: Willoughby, Ohio, Meister Publishing Company, 956 p.

Mueller, D.K., Hamilton, P.A., Helsel, D.R., Hitt, K.J., and Ruddy, B.C., 1995, Nutrients in ground water and surface water of the United States—An analysis of data through 1992: U.S. Geological Survey Water-Resources Investigations Report Rose, D.L., and Schroeder, M.P., 1995, Methods of analysis by the U.S. Geological Survey National Water Quality

Laboratory—Determination of volatile organic compounds in water by purge and trap capillary gas chromatography-mass spectrometry: U.S. Geological Survey Open-File Report 94-708, 26 r Rush, F.E., 1968. Index of hydrographic areas in Nevada: Nevada Division of Water Resources Information Report 6, 38 p.

Shelton, L.R., 1994, Field guide for collecting and processing stream-water samples for the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 94-455, 42 p. Smith, J.A., Witkowski, P.J., and Fusillo, T.V., 1988, Manmade organic compounds in the surface waters of the United

States—A review of current understanding: U.S. Geological Survey Open-File Report 87-209, 182 p. Squillace, P.J., Zogorski, J.S., Wilber, W.G., and Price, C.V., 1996, Preliminary assessment of the occurrence and possible sources of MTBE in groundwater in the United States, 1993-1994: Environmental Science and Technology, v. 30, no. 5,

Thatcher, L.L., Janzer, V.J., and Edwards, K.W., 1977, Methods for determination of radioactive substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A5, 95 p. Thodal, C.E., 1992, Data on ground-water quality, Carson Valley and Topaz Lake areas, Douglas County, Nevada, for year ending September 1987: U.S. Geological Survey Open-File Report 90-146, 44 p.

Thomas, J.M., and Lawrence, S.J., 1994, Ground-water quality and geochemistry in Dayton, Stagecoach, and Churchill Valleys, wester Nevada: U.S. Geological Survey Open-File Report 93-356, 69 p. U.S. Environmental Protection Agency, 1996, Drinking water regulations and health advisories: U.S. Environmental

Protection Agency, Office of Water, Report EPA-822-R-96-001, 16 p.

U.S. Geological Survey, 1995, Pesticides in the atmosphere: U.S. Geological Survey Fact Sheet FS-152-95, 4 p. Van Denburgh, A.S., Lamke, R.D., and Hughes, J.L., 1973, A brief water-resources appraisal of the Truckee River Basin,

western Nevada: Nevada Division of Water Resources, Reconnaissance Report 57, 122 p. Welsch, E.P., Crock, J.G., and Sanzolone, R., 1990, Trace-level determination for arsenic and selenium using continuous-flow hydride generation atomic absorption spectrophotometry, in Arbogast, B.F., ed., Quality-assurance manual for the Branch of Geochemistry: U.S. Geological Survey Open-File Report 90-668, p. 38-45.

water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A3,

Wershaw, R.L., Fishman, M.J., Grabbe, R.R., and Lowe, L.E., 1987, Methods for the determination of organic substances in

Table 1. Selected primary and secondary maximum contaminant levels and adult lifetime health advisories for drinking water (from U.S. Environmental [Abbreviations and symbol: D, draft; F, final; P, proposed; U, under review, µg/L, micrograms per liter; mg/L. milligrams per liter; pCi/L, picocuries per liter, --, not available.]

	Primary maximum contaminant level (and stetus)	(and stetus)	health advisor (and slatus)
	Inorga	nics	
Antimony	6 μg/L (F)		3 μg/L (F
Aluminum	-	$50-200 \mu g/L (F)$	
Arsenic	50 μg/L (U)		-
Barium	$2,000 \mu\text{g/L}$ (F)		2.000 µg/L (F
Beryllium	4 μg/L (F)	-	
Cadmium	5 μg/L (F)		E 11
Chloride	J μg/L (I')	250 (T)	5 μg/L (F
Chromium	100 μg/L (F)	250 mg/L (F)	100 7 (77
Copper	100 μg/L (F)	1 000 # (F)	100 μg/L (F
Fluoride	4 ma/((II)	1.000 µg/L (F)	
Iron	4 mg/L (U)	300 μg/L (F)	
		300 AG/L (1)	-
Lead	15 μg/L (F)		•-
Manganese		50 μg/L (F)	
Molybdenum			40 μg/L (D
Nickel	a100 μg/L (F)	-	100 μg/L (F)
Nitrate (as N)	10 mg/L (F)		(F)
	6.207		
Nitrate+Nitrite (as N)	10 mg/L (F)		
Nitrite (as N)	1 mg/L (F)		
Selenium	50 μg/L (F)	_	**
Silver	σο με/L(1)	100 μg/L (F)	
Solids, dissolved		500 mg/L (F)	
		ooo mgr (1)	
Sulfate	500 mg/L (P)	250 mg/L (F)	
Zinc		5,000 μg/L (F)	2,000 μg/L (F)
	B "		2,000 μg/L (F)
Radon	Radionuc	lides	
Uranium	*300 pCi/L (P)	-	
Claithill	20 μg/L (P)		
	Organi	cs	
Aldicarb	7 μg/L (D)		7 μg/L (D)
Atrazine	3 μg/L (F)		
Benlazon	-		20 μg/L (F)
Benzene	5 μg/L (F)		
Bromoform	^b 100 μg/L (P)		
Carbaryl			
Carbaryi	40 7 7		700 μg/L (F)
Chloroform	40 μg/L (F)		$40 \mu\text{g/L} (\text{F})$
	^b 100 μg/L (F)		
Chlorpyrifos Dacthal	-		$20 \mu g/L (F)$
Dacinai	-		4.000 μg/L (F)
Dichlorodifluoromethane			1 000 7 -
Diazinon			1,000 μg/L (F)
1,2 Dichloroethane	5 ug/I (E)		0.6 μg/L (F
Dinoseb	5 μg/L (F)		
Diuron	7 μg/L (F)		10 7 (7)
- (m1 011			10 μg/L (F)
Lindane	0.2 μg/L (F)		02
Malathion	0.2 μg/L (I')	_	0.2 μg/L (F
MCPA			200 μg/L (F)
Methomyl			10 μg/L (F)
Metolachlor	40 μg/L (F)		200 μg/L (F)
	TO AND (F)		40 μg/L (F)
Melhyl tert-butyl ether		**	C20_200
Phenois			^c 20-200 μg/L (D)
Picloram			4,000 μg/L (D)
rometon			500 μg/L (F)
Simazine	4 μg/L (F)		100 μg/L (D)
	, WELL (I.)		4 μg/L (F)
.4-D	70 μg/L (F)		70 T (E)
,4,5-T	70 μg/L (Γ)		70 μg/L (F)
erbacil			70 μg/L (F)
	5 ng/L (E)		90 μg/L (F)
etrachloroethylene	$5 \mu g/L (F)$		
etrachloroethylene richloroethylene	5 μg/L (F)		

Table 4. Dissolved nutrients and dissolved organic carbon in water samples from monitoring wells in Reno-Sparks area, 1994-95 [Sample-collection dates correspond to those listed in table 2. Abbreviations and symbols: mg/L, milligrams per liter, <, less than;

te). .1)	Nitrogen, nitrite+ nitrate (mg/L as N)	Nitrogen, nitrite (mg/L as N)	Nitrogen, ammonia (mg/L as N)	Nitrogen, ammonia+ organic (mg/L as N)	Orthophos- phorus (mg/L as P)	Phosphorus (mg/L as P)	Carbon, organic (mg/L as C)
			Shallow !	Monitoring Wells	3		
1	3.0	0.02	0.02	<0.2	0.07	0.08	0.6
2	6.5	.05	.03	<.2	.22	.24	2.7
3	4.7	.02	.02	.4	.12	.11	6.7
4	5.2	.01	.03	<.2	.13	.13	1.9
5	2.9	<.01	.03	.4	.14	.14	1.3
6	.76	<.01	.02	<.2	16	16	
7	10	<.01	.04	.3	.16	.16	1.3
8	.56	.01	.01	<.2	.05	.08	4.2
9	1.8	<.01	.01		.10	.11	1.2
0	<.05	<.01	.04	<.2	.03	.03	.7
1				<.2	.09	.07	2.4
2	<.05 .56	<.01 .01	.42	.5	.17	.18	1.6
3	2.2	<.01	.02	.3	<.01	.01	
4	1.4		.03	<.2	.11	.13	.4
5	2.0	.02	.05	.2	.02	.02	1.1
			.07	.4	.19	.20	1.1
5 7	7.8 5.2	.11	.03	<.2	.11	.09	1.4
8		.06	.04	<.2	.19	.18	1.5
9	.82 <.05	.02	<.01	<.2	.14	.11	1.8
)		<.01	.03	<.2	.10	.13	.3
,	6.0	.03	.06	<.2	.11	.09	.9
l	1.4	<.01	.02	<.2	.01	.01	.2
2	.50	<.01	.07	.2	1.1	1.0	1.6
3	1.9	<.01	<.01	<.2	.23	.21	1.1
1	.74	.05	.01	<.2	.08	.09	1.7
5	4.8	.02	.04	<.2	.25	.23	1.4
5	5.4	<.01	.02	<.2	.44	.41	
7	.66	<.01	.02	<.2	.07	.07	2.4
	1.1	<.01	.02	<.2	.02	.03	.8
			Water-	Supply Wells			
	3.60	<.01	<.015	<.2	.02	.03	2
	1.3	<.01	<.015	<.2	.05	.06	.2 .2
	.67	<.01	<.015	<.2	.06	.06	14
	.08	<.01	.11	<.2	.19		2
	2.7	<.01	<.015	<.2	.03	.56 .02	.2
	1.0	<.01	.03	<.2	.05	.04	.3
	3.5	<.01	.02	<.2	.04	.03	.3 .2
	1.9	<.01	<.015	.2			
	<.05	<.01	.03	<.2	.06	.05	.2
	.59	<.01	.02	<.2	.01	<.01	1.7
	.77	.01	<.015	<.2	.08	.08	.2
	1.7	<.01	.020	<.2	.04	.05 .05	<.1 .2
	1.7	<.01	.020	<.2			
	.28	<.01	<.015	<.2	.04	.03	.8
	.63	<.01	<.015	<.2	.05	.04	.1
	.75	<.01	<.015	<.2	.05	.09	.1
	1.2	<.01	.03	<.2	.05	.06	.3
	.29	<.01	<.01	<.2	.03	<.01	.5
		1101		1.4	.02	.03	.1

Figure 1. Location of monitoring wells, land use, and selected water-quality characteristics for ground-water samples collected from Reno-Sparks area, Nevada, 1994 and 1995. Table 5. Dissolved trace elements in water samples from monitoring wells in Reno-Sparks area, 1994-95 [Sample-collection dates correspond to those listed in table 2. Abbreviations and symbols: µg/L, microgams per liter, <, less than]

0 5 to 15 20 KILOMETERS

Index map showing drainage basins in Nevada Basin and Range

study unit and location of Reno-Sparks area discussed in this report.

Site no. (fig. 1)	Anti- mony (µg/L as Sb)	Alum- inum (µg/L as Al)	Arsenic (μg/L as As)	Barium (μg/L as Ba)	Beryl- lium (μg/L as Be)	Cad- mium (μg/L as Cd)	Chro- mium (µg/L as Cr)	Cobalt (μg/L as Co)	Copper (µg/L as Cu)	Iron (μg/L as Fe)	Lead (μg/L as Pb)	Manga- nese (μg/L as Mn)	Molyb- denum (μg/L se Mo)	Nickel (μg/L as Ni)	Silver (µg/L as Ag)	Selenium (µg/L as Se)	Zind (µg/l as Zi
							Sha	llow Moni	itoring We	ells		-	_	_			
1 2 3 4 5	<1 <1 <1 <1	1 2 2 2 2 2	11 7 15 2 3	73 120 87 110 170	<1 <1 <1 <1 <1	<1.0 <1.0 <1.0 <1.0 <1.0	<1 6 9 4 7	<1 <1 <1 <1	<1 2 2 1 6	3 <3 4 4 <3	<1 <1 <1 <1 <1	9 100 8 370 21	12 3 19 2 2	<1 2 1 <1 1	<1.0 <1.0 <1.0 <1.0 <1.0	2 3 2 1 <1	<1 <1 <1 <1
6 7 8 9	<1 <1 <1 <1 <1	2 <1 2 2 <1	13 2 5 1 20	41 180 60 41 82	<1 <1 <1 <1 <1	<1.0 <1.0 <1.0 <1.0 <1.0	5 4 4 <1 7	<1 4 <1 <1 <1	1 3 1 <1 5	<3 <3 <3 3 240	<1 <1 <1 <1	53 470 300 <1 170	26 2 5 2 25	<1 1 <1 <1 <1 2	<1.0 <1.0 <1.0 <1.0 <1.0	2 <1 <1 <1 <1	<1 4 <1 <1 3
11 12 13 14 15	<1 <1 <1 <1 <1	10 2 3 <1 3	19 2 3 <1 3	73 71 83 72 45	<1 <1 <1 <1 <1	<1.0 <1.0 <1.0 <1.0 <1.0	3 2 4 6 <1	<1 2 <1 2 2	<1 <1 <1 3 2	2,300 3 <3 <3 11	<1 <1 <1 <1	1,600 1400 28 600 270	3 20 2 3 6	<1 1 <1 4 4	<1.0 <1.0 <1.0 <1.0 <1.0	<1 <1 <1 <1	<1 5 <1 2 3
16 17 18 19 20	<1 <1 <1 <1 <1	<1 10 3 3 4	33 64 10 36 19	80 33 30 46 83	<1 <1 <1 <1	<1.0 <1.0 <1.0 <1.0 1.0	6 6 4 <1 5	<1 <1 <1 <1 <1	1 1 3 <1 2	10 10 8 29 <3	<1 <1 <1 <1	250 100 360 240 200	13 13 7 11 22	2 1 2 <1 2	<1.0 <1.0 <1.0 <1.0 <1.0	2 <1 <1 <1 3	<1 <1 <1 <1 2
21 22 23 24 25	4 <1 <1 <1 <1	10 9 <1 2 <1	130 230 5 3 2	12 4 140 210 220	<1 <1 <1 <1	<1.0 1.0 <1.0 <1.0 1.0	3 4 4 7 6	<1 <1 <1 <1 <1	<1 3 1 <1	10 6 6 <3 <3	<1 <1 <1 <1 <1	4 <1 60 84 35	15 500 9 5 <1	<1 <1 2 2 <1	<1.0 <1.0 <1.0 <1.0 <1.0	<1 <1 <1 <1 <1	<1 2 3 2 2
26 27 28	<1 <1 <1	<1 1 1	7 54 4	280 370 85	<1 <1 <1	<1.0 <1.0 <1.0	5 8 6	<1 <1 <1	1 <1 <1	3 3 3	<1 <1 <1	1 <1 <1	<1 <1 <1	<1 <1 <1	<1.0 <1.0 <1.0	<1 <1 <1	1 <1 <1
29	-1	2	,	01				ater-Supp									
30	<1 <1	3	6 8	81 28	<1 <1	1.0	3 2	<1 <1	2 2	<3 <3	1 2	<1 <1	2 2	6	<1.0 <1.0	1 <1	1 3
31 32 33 34 35	<1 <1 <1 <1 <1	1 6 4 2 2	19 83 1 16 3	25 24 57 35 62	<1 <1 <1 <1 <1	<1.0 <1.0 <1.0 <1.0 <1.0	<1 1 2 1 1	<1 <1 <1 <1 <1	6 <1 4 2 2	<3 12 <3 6 5	2 <1 3 2 3	<1 53 <1 <1 3	4 11 <1 2 2	4 <1 3 4 7	<1.0 <1.0 <1.0 <1.0 <1.0	<1 <1 <1 <1	5 1 5 2 1
36 37 38 39 40	<1 5 <1 <1 <1	3 5 4 10 3	3 92 4 5 2	51 27 46 100 99	<1 <1 <1 <1 <1	<1.0 <1.0 <1.0 16 <1.0	2 <1 <1 20 2	<1 <1 <1 <1	1 <1 4 12 3	4 17 <3 19 <3	<1 <1 <1 3 2	<1 21 <1 <1 <1	1 29 3 1 <1	4 1 1 5 <1	<1.0 <1.0 <1.0 <1.0 <1.0	<1 <1 <1 <1 <1	3 1 74 6 2
41 42 43 44 45 46	1 <1 <1 <1 <2 <1 <2 <1	3 4 2 2 2	16 7 4 1 24 <1	200 45 62 70 66 120	<1 <1 <1 <1 <1 <1	<1.0 <1.0 <1.0 <1.0 <2.0 <1.0	3 3 2 2 3 1	<1 <1 <1 <1 <1 <1	4 2 <1 5 3 28	10 <3 <3 <3 <3 34 15	1 <1 <1 <1 <1 <1 <1 <1	26 <1 <1 <1 1 5	2 2 2 2 2 <1	2 3 3 5 6	<1.0 <1.0 <1.0 <1.0 8.0 <1.0 <1.0	<1 <1 <1 <1 <1	56 2 <1 8 <1 210

Table 6. Volatile organic compounds detected in water samples from monitoring wells in Reno-Sparks area, 1994-95 [Sample-collection dates correspond to those listed in table 2. Abbreviations and symbols: µg/L, micrograms per liter; <, less than; --, not determined]

Base from U.S. Geological Survey digital data, 1:100,000, 1978-87

Standard parallels 29° 30' and 45° 30', central meridian -115° 00'

Site no. ig. 1)	Benzene (μg/L)	Bromo- form (µg/L)	Chloro- ethane (µg/L)	Chloro- form (µg/L)	Dichloro- di-fluoro- methane (μg/L)	1,2-Dichloro- elhane (μg/L)	Freon- 113 (µg/L)	Methyl tert-butyl ether (µg/L)	Phenois (µg/L)	Tetrachloro- ethylene (μg/L)	Trichloro- ethylene (μg/L)
					Shallow N	Ionitoring Weli	s			-	
1	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	<0.2	< 0.2	< 0.2	3	< 0.2	<0.2
2	<.2	<.2	.2	<.2	<.2	<.2	<.2	<.2	1	<.2	<.2
3	<.2 <.2	<.2 <.2	<.2	<.2	<.2	<.2	<.2	<.2	<1	<.2	<.2
5	<.2	<.2	.3	<.2 .3	<.2 <.2	<.2	<.2	140	<1	.8	<.2
						<.2	<.2	<.2	<1	<.2	4.9
6	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1	<.2	<.2
8	5.0 <.2	<.2 <.2	<.2	<.2	<.2	<.2	<.2	220	4	15	.3
9	<.2	<.2	.5 <.2	<.2 <.2	<.2	<.2	<.2	.3	<1	<.2	<.2
10	<.2	<.2	<.2	<.2	<.2 <.2	<.2	<.2	<.2	4	<.2	<.2
							<.2	6.2	1	<.2	.3
11 12	<.2	<.2 <.2	<.2	<.2	<.2	<.2	<.2	<.2	<1	<.2	<.2
13	<.2	<.2	<.2	.5	<.2	<.2	<.2	<.2		<.2	<.2
14	<.2	<.2	<.2	<.2 <.2	<.2 <.2	<.2	10	<.2	<1	<.2	<.2
15	<.2	<.2	<.2	1.2	<.2	<.2 <.2	<.2 <.2	1.4	<1 4	<.2 <.2	<.2
16	<.2	<.2	<.2								<.2
17	<.2	<.2	.2	.4 .9	<.2 <.2	<.2 <.2	<.2	<.2	<1	1.3	<.2
18	<.2	<.2	<.2	<.2	<.2	<.2	<.2 <.2	.8 <.2	<1	20 <.2	.9
19	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1 1	<.2	<.2 <.2
20	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	i	<.2	<.2
21	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	3		
22	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1	<.2 <.2	<.2
23	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1	<.2	<.2 <.2
24	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	2	<.2	<.2
25	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1	<.2	<.2
26	<.2	<.2	<.2	.3	<.2	<.2	<.2	<.2		<.2	<.2
27	<.2	<.2	.3	<.2	<.2	<.2	<.2	<.2	3	<.2	<.2
28	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1	<.2	<.2
					Water-S	Supply Wells					
29	<.2	<.2	<.2	.3	<.2	<.2	<.2	<.2	1	1.3	2.2
30	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1	.8	<.2
31	<.2	<.2	<.2	.3	<.2	<.2	<.2	<.2	1	<.2	<.2
32	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1	<.2	<.2
33	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	3	1.1	<.2
34	<.2	<.2	<.2	.4	<.2	<.2	<.2	<.2	<1	<.2	<.2
35	<.2	<.2	<.2	.3	<.2	<.2	<.2	<.2	<1	<.2	<.2
36	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1	<.2	<.2
37	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1	<.2	<.2
38	<.2 <.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1	<.2	<.2
10	<.2	<.2 <.2	<.2 <.2	<.2 <.2	<.2 <.2	<.2	<.2	<.2	<1	<.2	<.2 <.2
						<.2	<.2	<.2	<1	<.2	
1 2	<.2 <.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	3	<.2	<.2
3	<.2	<.2 <.2	<.2	<.2	<.2	<.2	<.2	<.2	2	<.2	<.2
4	<.2	<.2	<.2	<.2 <.2	<.2 <.2	<.2	<.2	<.2	<1	<.2	<.2
5	<.2	<.2	<.2 <.2	<.2	<.2	<.2 <.2	<.2 <.2	<.2 <.2	<1 3	<.2	<.2
6	<.2	.4	<.2	.3	.3	<.2	<.2	<.2	<1	<.2 <.2	<.2 <.2

in Reno-Sparks area, 1994-95 [Sample-collection dates correspond to those fisted in table 2. Abbreviations and symbols: $\mu g/L$, micrograms per liter: --, not determined; <, less than; E, estimated a]

Table 7. Dissolved pesticides detected in water samples from monitoring wells

119° 45' 00"

Shallow Monitoring Wells

43 <.001 <.003 <.002 <.002 <.04 <.002 <.006 <.018 <.005 <.007 44 <.001 <.003 <.002 <.002 <.04 <.002 <.06 <.018 <.005 <.007 45 <.001 <.003 <.002 <.002 <.02 <.02 <.02 <.000 <.018 <.005 <.007 45 <.001 <.003 <.002 <.002 <.02 <.02 <.002 <.06 <.018 <.005 <.007 45 <.001 <.003 <.002 <.002 <.02 <.02 <.002 <.06 <.018 <.005 <.007 45 <.001 <.003 <.002 <.002 <.002 <.002 <.002 <.002 <.003 <.002 <.003 <.002 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <.003 <. 46 <.001 <.003 E.003 <.002 <.02 <.002 <.006 <.018 <.005 <.007 ^a "E" is assigned by Laboratory under following circumstances: (1) reported concentration is less than detection limit or less than 0.004 µg/L, whichever is greater, for peak measured at correct retention time and qualified with spectral match of target analyte; (2) reported concentration is greater than highest calibration point (equiv-

alent to analyte concentration of 4 µg/L in sample); or (3) reported concentration for carbaryi, deethyl atrazine, or

INTERIOR-GEOLOGICAL SURVEY, RESTON, VIRGINIA-1997

terbacil is of uncertain accuracy.

Data on Ground-Water Quality, Reno-Sparks Area, Nevada, 1994 and 1995 Kenneth J. Covay and Hugh E. Bevans